

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD****WASTE TREATMENT LAGOON**

(No.)

CODE 359**DEFINITION**

A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

PURPOSE

To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

CONDITIONS WHERE PRACTICE APPLIES

- Where the lagoon is a component of a planned agricultural waste management system.
- Where treatment is needed for organic wastes generated by agricultural production or processing.
- On any site where the lagoon can be constructed, operated and maintained without polluting air or water resources.
- To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.

CRITERIA**General Criteria for All Lagoons**

Laws and Regulations. All Federal, state, and local laws, rules, and regulations governing the construction and use of waste treatment lagoons must be followed.

Location. To minimize the potential for contamination of streams, lagoons should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. Lagoons shall be located so the potential impacts from breach of embankment, accidental

release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Lagoons should be located so they have as little drainage area as possible. If a lagoon has a drainage area, the volume of normal runoff during the treatment period and the design storm event runoff shall be included in the required volume of the lagoon.

The Missouri Department of Natural Resources requires the separation distance between the location of waste treatment lagoon and a well to be a minimum of 300 feet.

The lagoon should be located such that water is available to prefill the structure to a depth of 2 feet in order to protect the compacted clay liner.

Soils and Foundation. The lagoon shall be located in soils with an acceptable permeability and stability against collapse. The Missouri Department of Natural Resources, Geological Survey and Resource Assessment Division will be contacted for their comments regarding the geological suitability. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D (National Engineering Manual, Part 651).

The lagoon shall have a bottom elevation that is a minimum of 4 feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, lagoon seepage rates, and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains to meet this requirement.

The Missouri Department of Natural Resources requires the following lagoon liner as a minimum:

- A clay liner designed in accordance with procedures of AWMFH, Appendix 10D with a thickness and coefficient of permeability so that specific discharge is significantly less than 1×10^{-7} cm/sec.,
Or one of the following:
- A flexible membrane liner,
- A geosynthetic clay liner (GCL) flexible membrane liner,
- A concrete liner designed in accordance with slabs on grade criteria, Waste Storage Facility (313), for fabricated structures requiring water tightness.

Soil Amendments. Soil amendments may be used to create a clay liner with the required permeability. Soil amendments shall meet or exceed the requirements of Missouri conservation practice standard Pond Sealing or Lining, Soil Dispersant (code 521B)

Flexible Membranes. Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in Missouri conservation practice standard Pond Sealing or Lining, Flexible Membrane (code 521A).

Required Volume. The lagoon shall have the capability of storing the following volumes:

- Volume of accumulated sludge for the period between sludge removal events;
- Minimum treatment volume (anaerobic lagoons only);
- Volume of manure, wastewater, and other wastes accumulated during the treatment period;
- Depth of normal precipitation less evaporation on the surface area (at the required volume level) of the lagoon during the treatment period;
- Depth of the 25-year, 24-hour storm precipitation on the surface area (at the required volume level) of the lagoon or for certain permit situations 100-year, 24-hour storm precipitation.

Treatment Period. The treatment period is the detention time between drawdown markers. It shall be the time required to provide the storage that allows environmentally safe utilization of

waste considering the climate, crops, soil, and equipment requirements; or as required by local, state, and Federal regulations.

Waste Loading. Daily waste loading shall be based on the maximum daily loading considering all waste sources that will be treated by the lagoon. Reliable local information or laboratory test data should be used if available. If local information is not available Chapter 4 of the AWMFH may be used for estimating waste loading.

Embankments. The minimum elevation of the top of the settled embankment shall be 2 foot above the lagoon's maximum operating level (upper pump down level). This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 1. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

Table 1 – Minimum Top Widths

Total Embankment Height (feet)	Top Width (feet)
14.9 or less	8
15 – 19.9	10
20 – 24.9	12
25 – 29.9	14
30 – 35	15

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and ultraviolet ray deterioration, while incorporating erosion protection as necessary. Inlets shall be provided with a water-sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces. The minimum diameter pipe used will be 4-inch for settled wastewater or milk barn drains and 6-in for unsettled wastewater.

Outlet. Outlets from the required volume shall be designed to resist corrosion and plugging. No outlet shall automatically discharge from the lagoon. Lagoons having a maximum design liquid level of 3 feet or more above natural ground line shall be provided with an emergency

spillway to prevent overtopping. The emergency spillway, when used, shall have a minimum bottom width of 4 feet.

Facility for Drawdown (Pump Down).

Measures that facilitate safe drawdown of the liquid level in the lagoon shall be provided. Access areas and ramps used to withdraw waste shall have slopes that facilitate a safe operating environment. Docks, wells, pumping platforms, retaining walls, etc. shall permit drawdown without causing erosion or damage to liners.

Sludge Removal. Provision shall be made for periodic removal of accumulated sludge to preserve the treatment capacity of the lagoon.

Erosion Protection. Embankments and disturbed areas surrounding the lagoon shall be treated to control erosion. This includes the inside slopes of the lagoon as needed to protect the integrity of the liner. The outer slopes will be seeded with grasses according to Critical Area Planting (Code 342).

Safety. Design shall include appropriate safety features to minimize the hazards of the lagoon. The lagoon shall be fenced around the perimeter and warning signs posted to prevent children and others from using it for other than its intended purpose.

Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Required Volume.

Features, safeguards, and/or management measures to minimize the risk of embankment failure or accidental release, or to minimize or mitigate impact of this type of failure shall be considered when any of the categories listed in Table 2 might be significantly affected.

The following shall be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments:

- An auxiliary (emergency) spillway
- Additional freeboard
- Storage volume for the wet year rather than normal year precipitation
- Reinforced embankment -- such as, additional top width, flattened and/or armored downstream side slopes
- Secondary containment

- Water level indicators or recorders

The following shall be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 2 may be significantly affected:

- Outlet gate locks or locked gate housing
- Secondary containment
- Alarm system
- Another means of emptying the required volume

Table 2- Potential Impact Categories from Breach of Embankment or Accidental Release

1. Surface water bodies -- perennial streams, lakes, wetlands, and estuaries
2. Critical habitat for threatened and endangered species
3. Riparian areas
4. Farmstead, or other areas of habitation
5. Off-farm property
6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places

Additional Criteria for Anaerobic Lagoons

Loading Rate. Anaerobic lagoons shall be designed to have a minimum treatment volume based on Volatile Solids (VS) loading per unit of volume. The maximum loading rate shall be as indicated in AWMFH Figure 10-22 or according to state regulatory requirements, whichever is more stringent. If odor control is desired the loading shall be 50% of the value listed in AWMFH.

Operating Levels. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event precipitation on the surface of the lagoon and areas that drain into the lagoon or for certain permit situations 100-year, 24-hour storm precipitation. The maximum drawdown level shall be the lagoon level that provides volume for the required minimum treatment volume plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below

the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth Requirements. The minimum depth at maximum drawdown shall be 6 feet. If subsurface conditions prevent practicable construction to accommodate the minimum depth at maximum drawdown, a lesser depth may be used, if the volume requirements are met.

Additional Criteria for Naturally Aerobic Lagoons

Loading Rate. Naturally aerobic lagoons shall be designed to have a minimum treatment surface area as determined on the basis of daily BOD₅ loading per unit of lagoon surface. The required minimum treatment surface area shall be the surface area at maximum drawdown. The maximum loading rate shall be as indicated by AWMFH Figure 10-25 or according to state regulatory requirements, whichever is more stringent.

Operating Levels. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event on the lagoon surface or for certain permit situations 100-year, 24-hour storm precipitation. The maximum drawdown level shall be the lagoon level that provides volume for the volume of manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth Requirements. The minimum depth at maximum drawdown shall be 2 feet. The recommended maximum liquid level shall be 5 feet.

Additional Criteria for Mechanically Aerated Lagoons

Loading Rate. Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD₅ loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide a minimum of 1 pound of oxygen for each pound of daily BOD₅ loading.

Operating Levels. The maximum operating level shall be the lagoon level that provides the required lagoon volume less the 25-year, 24-hour storm event precipitation or for certain permit situations 100-year, 24-hour storm precipitation and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of the aeration equipment. This marker shall be referenced and described in the O&M plan.

CONSIDERATIONS

General

Lagoons should be located as close to the source of waste as possible.

Solid/liquid separation treatment should be considered between the waste source and the lagoon to reduce loading.

The configuration of the lagoon should be based on the method of sludge removal and method of sealing.

Due consideration should be given to economics, the overall waste management system plan, and safety and health factors.

Considerations for Improving Air Quality

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor:

- Reduce the recommended loading rate for anaerobic lagoons to one-half the values given in AWMFH Figure 10-22.
- Use additional practices such as Anaerobic Digester – Ambient Temperature (365), Anaerobic Digester – Controlled Temperature (366), Waste Facility Cover (367) and Composting Facilities (code 317) in the waste management system.
- Liquid/solid separation prior to discharge to lagoon will reduce volatile solids (VS) loading resulting in reduced gaseous emissions and odors. Composting of solids will further reduce emissions.
- Design lagoons to be naturally aerobic or to allow mechanical aeration.

Adjusting pH below 7 may reduce ammonia emissions from the lagoon but may increase odor when waste is surface applied (See Conservation Practice Waste Utilization, code 633).

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use. Missouri standard drawings and construction specifications, or equivalent, will be used as applicable to the site.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for design. The plan shall contain the operational requirements

for drawdown and the role of permanent markers. This shall include the requirement that waste be removed from the lagoon and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, the plan shall include a strategy for removal and disposition of waste with least environmental damage during the normal treatment period to the extent necessary to insure the lagoon's safe operation. This strategy shall also include the removal of unusual storm events.

Development of an emergency action plan should be considered for lagoons where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.

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**NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI CONSTRUCTION SPECIFICATION**

FOR

WASTE TREATMENT LAGOON

(359)

General

Construction operations shall be carried out in such a manner and sequence that erosion, air and water pollution will be minimized. **A land disturbance permit from the Missouri Department of Natural Resources is needed if the disturbed area is greater than one (1) acre in size.**

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

Foundation preparation

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod, debris, and frozen soil. The topsoil and sod are to be stockpiled. After stripping, the foundation area will be prepared to assure bond with the fill by removing loose dry material, scarifying, disking, adjusting moisture, and compacting as necessary.

Excavation

The completed excavation shall conform to the lines, grades, and elevations shown on the drawings. Over excavation will be checked by the engineer.

Clay liner

A clay liner shall be installed as designated on the drawings. This work shall consist of constructing an impermeable earth liner for the inside slopes and the bottom of the earthen basin to the thickness shown on the drawings. Only soils approved by the engineer will be used. The soil shall be from designated borrow areas or as staked in the field. Compaction of the earthen liner shall be as specified in the Fill

Placement section of this specification unless otherwise specified on the drawings or the Additional Details section of this specification.

Suitable, in-place clay material in the bottom of the earthen basin and on the side slopes, may be used as the clay liner, if approved by the engineer. In this case, the lower 6 inches of excavation need not be removed but only scarified in place prior to compaction. Also, half of the liner may be constructed at a time to avoid removing the excavated material from the entire basin area. All areas, within the basin, disturbed by construction shall be scarified and recompacted as specified. Care shall be taken to assure that all of the clay liner is continuous within the area protected.

If insufficient or unsuitable clay material is encountered during construction, use of artificial liners may be necessary. Consult with the designer to determine necessary actions for either case if it is not shown on the drawings.

Artificial liners shall meet the requirements of Missouri Construction Specification 521A Pond Sealing or Lining. Soil amendments may also be used to create an impervious layer. Soil amendments shall meet the requirements of Missouri Construction Specification 521B Pond Sealing or Lining – Soil Dispersant.

Fill placement

The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones with diameters more than one-half the layer thickness and other objectionable material. To the extent they are suitable (CL, CH, GC, SC), excavated materials are to be used as fill. The fill shall be homogeneous and shall contain no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. All earthfill shall be placed to act as an impermeable barrier.

The placing and spreading of the fill shall be started at the lowest point of the foundation and the fill shall be brought up in approximately horizontal layers not to exceed 9 inches in thickness. Each layer shall be spread, processed and compacted by two passes of standard tamping type roller over the entire area to be compacted.

The tamping-type roller shall have tampers or feet projecting not less than six (6) inches from the surface of the drum and shall have a minimum static load on each tamper of 250 pounds per square inch of tamping area. Tamping rollers with minimum static load on each tamper of 125 pounds per square inch of tamping area may be used if the number of passes is increased to four (4) or the thickness of lifts is reduced to four (4) inches. (Sheepsfoot or wedgefoot drum rollers are considered tamping rollers.)

If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before next layer is placed.

Moisture control

The minimum moisture content of the fill material and foundation shall be such that, when kneaded in the hand, the fill material will form a ball which does not readily separate. The maximum moisture content is when conditions are too wet for efficient use of the hauling and compaction equipment. It is beneficial to place earthfill for the clay liner in as moist a condition as practicable.

To avoid drying cracks, the clay liner shall be kept moist. This will be accomplished by prefilling the earthen basin with water to two (2) feet above the basin bottom.

Inlet structures

Concrete or rock riprap chutes, designed to prevent erosion of the clay liner, shall be installed as shown on the drawings.

The inlet structure or conduit shall be placed on a firm foundation to the lines and grades shown on the drawings.

Materials

Materials required and fabrication details shall be as specified on the drawings and as shown below.

Installation and materials for concrete and reinforcing steel shall conform to Missouri Construction Specification 750 Reinforced Concrete.

Rock riprap and bedding shall be sound, durable rock conforming to gradation shown on drawings. Geotextile may be used in lieu of riprap bedding. Metal, concrete blocks, and drain materials shall be as shown on the drawings.

Geotextile fabric shall be non-woven, needle punched and materials and installation shall conform to Missouri Construction Specification 753 Geotextile.

Plastic pipe larger than 6 inch diameter shall be as shown on the drawings. Plastic pipe 5 inch in diameter or smaller shall be Schedule 40 PVC conforming to ASTM D1785 or SDR 21. PVC conforming to ASTM D2241 or equivalent. Corrugated tubing shall be Polyethylene Heavy Duty tubing conforming to ASTM F405 or equivalent.

Installation

Extreme caution must be exercised during backfill and compaction around structures or conduits to prevent damage, movement, or deflection. All intrusions into the clay liner will be backfilled and compacted to like conditions of the surrounding clay liner to maintain its integrity.

Placement of topsoil

Available topsoil should be placed on the top and the exposed slopes of the embankment as well as all areas disturbed by construction outside the pond area including the borrow areas.

Vegetation

Vegetate the embankment and surrounding disturbed areas to control erosion. Refer to Conservation Practice Standard Critical Area Planting (342) for seeding and Mulching (484) recommendations or equivalent.

Additional Details: _____

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**NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI OPERATION AND MAINTENANCE
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Operation: A maximum operating level (upper pumpdown) and lower pumpdown stake will be set in the lagoon. Pump before the wastewater level reaches the upper stake. Pumping is to cease when the lower pumpdown stake is reached. The markers will be permanently installed in the lagoon.

Over time, solids will accumulate in the bottom of the lagoon. Agitate prior to pumping in order to get some of the settled solids into suspension and break up floating mats. Failure to do this will shorten the life span of the facility.

Pump down the lagoon each fall to provide adequate storage through the winter and early spring.

Maintenance: Inspect the waste treatment lagoon periodically. Keep the grass mowed and weeds under control. Keep the embankment free of shrubs, trees, and burrowing animals.

Wastewater Utilization: The effluent from the waste treatment lagoon cannot be discharged to surface waters. Properly constructed, this lagoon will not leak. The lagoon could overflow if the amount of runoff and waste added is more than the amount of evaporation. This excess liquid must be properly disposed of to prevent water pollution. This can most easily be done by using irrigation equipment.

Apply the effluent to fields or ridge tops where slopes are less than 10 percent. Maintain 50 feet

of grassed buffer between the application area and facilities and streams. Do not spread effluent or manure solids within 50 feet of public roads or property lines. Provide a grassed buffer of 300 feet between the application area and losing streams, sinkholes, and wells.

Be "neighbor friendly" when pumping. Effluent may be odorous. Apply at times and to areas least affecting nearby residences.

Apply effluent at a rate of 1/2 inch per hour or less. A lower rate is required on fragipan or claypan soils. Do not apply over one inch per application.

Do not apply effluent or manure solid material immediately after a rain or within 12 hours of a forecasted rain. Do not apply to frozen or snow covered ground. Keep a record of where the material is spread.

Follow the application information in the Nutrient Management Plan. There is value in the manure product applied to the land. Use soils and effluent testing to guide in application. This will prevent pollution and help maximize profits.

Safety: Fence to exclude livestock, children, and others. Put up signs to warn others that the manure storage facility is dangerous.

Install a safety fence to prevent accidental entry of scraping equipment into the lagoon.

Additional Details: _____
